DESCRIPTION

Electronic Blood Pressure Monitor and Method of Calculating Blood Pressure Using the Same

Technical Field

The present invention relates generally to electronic blood pressure monitors and methods employing the same to calculate blood pressure and particularly to electronic blood pressure monitors that do not occlude a site to be measured with a pressure of no less than a systolic blood pressure so that the systolic blood pressure can be calculated with precision and methods employing the same to calculate blood pressure.

Background Art

A blood pressure measuring instrument having interest in the present invention is disclosed for example in Japanese Patent Laying-Open No. 4-180728. For example as described in this document a similarity between a cuff pressure waveform and an arterial pressure waveform is utilized and a cuff pressure pulse waveform's areal barycenter position is correlated to a cuff pressure for a maximum amplitude to determine a systolic blood pressure from a diastolic blood pressure.

Mr. Shimazu discloses in an article entitled "Idea to measure diastolic arterial pressure by volume oscillometric method in human fingers," Medical & Biological Engineering & Computing, Sept. 1986, pp. 549-554 employing volume oscillograph to determine a systolic blood pressure and a mean blood pressure and therefrom determining a diastolic blood pressure.

Furthermore, Japanese Patent Publication No. 5-58335 (Japanese Patent Laying-Open No. 62-292139) discloses utilizing a pressure lower than a systolic blood pressure to obtain a systolic blood pressure by extrapolation.

Japanese Patent Laying-Open No. 4-180728 discloses a method of measurement

utilizing a similitude between a cuff pressure pulse wave and an arterial pressure waveform. This method, however, correlates the cuff pressure pulse waveform's areal barycenter position to a cuff pressure exerted when a maximum amplitude appears, and its measurement theory is arguable in validity.

Furthermore, as described in Mr. Shimazu's article, a similitude between a volume pulse waveform and a blood pressure waveform detected via a photoelectric sensor at a finger tip to be measured is utilized to allow a systolic blood pressure to be determined with increased precision, and this requires exerting a cuff pressure to occlude a site to be measured to attain a pressure of no less than a systolic blood pressure.

Japanese Patent Publication No. 5-58335 (Japanese Patent Laying-Open No. 62-292139) discloses exerting a pressure lower than a systolic blood pressure for occlusion to determine a systolic blood pressure. This method, however, calculates the systolic blood pressure by an expression using an experimentally obtained, fixed constant, and thus suffers an error attributed to a variation attributed to a physiological difference between individual subjects.

Disclosure of the Invention

The present invention has been made to overcome such disadvantageous as described above and contemplates an electronic blood pressure monitor capable of measuring a systolic blood pressure non-invasively with high precision and a method employing the same to calculate blood pressure.

The present electronic blood pressure monitor having a cuff attached on a subject and pressurized and depressurized to measure the subject's blood pressure, includes: a pulse wave detector detecting the subject's pulse wave as the cuff occludes the subject; a mean blood pressure estimator estimating the subject's mean blood pressure from the pulse wave detected by the pulse wave detection means; a diastolic blood pressure detector detecting the subject's diastolic blood pressure; and a systolic

measurement. Thus measurement can provide a result further increased in reliability.

The electronic blood pressure monitor preferably further includes a blood pressure variation range display unit calculating a systolic blood pressure for each pulse wave of a plurality of pulses obtained during measurement, and displaying how a plurality of systolic blood pressures vary in value. Thus, systolic blood pressure can be calculated for each pulse waveform of a plurality of pulses obtained during measurement and the obtained systolic blood pressure values' variation can be represented numerically or diagrammatically. By confirming displayed item(s) the user can confirm respiratory blood pressure variation, variation attributed to arrhythmia, and the like.

The present invention in another aspect provides a blood pressure calculation method employing an electronic blood pressure monitor having a cuff attached on a subject and pressurized and depressurized in order to calculate the subject's blood pressure, including the steps of: detecting a pulse wave of the subject occluded by the cuff; estimating the subject's mean blood pressure from a pulse wave detected; detecting the subject's diastolic blood pressure; and calculating the subject's systolic blood pressure from an estimated mean arterial pressure, the detected diastolic blood pressure and the detected pulse wave's waveform.

An estimated mean arterial pressure, a detected diastolic blood pressure and a pulse wave's waveform can be used to calculate a systolic blood pressure. Systolic blood pressure can thus be measured non-invasively with high precision.

The step of detecting a pulse wave includes the step of calculating a waveform parameter indicative of a feature of a waveform of a pulse wave detected, and the step of calculating a diastolic blood pressure using the waveform parameter.

In the step of estimating a mean blood pressure the waveform parameter is used to determine a reference pressure point within any range of no more than a systolic blood pressure to no less than a diastolic blood pressure and calculates an estimated mean arterial pressure with reference to the reference pressure point by a waveform parameter correlated with an average of intra-arterial pressure waveform.

In the step of calculating a systolic blood pressure, the diastolic blood pressure and the estimated mean arterial pressure are correlated to the pulse waveform's minimum and average values and a blood pressure corresponding to the pulse waveform's maximum value point is calculated to determine systolic blood pressure.

The method further includes the step of correcting a distortion in waveform, correcting the waveform parameter to cancel an error introduced by a distortion of a detected pulse waveform relative to the intra-arterial pressure waveform into systolic blood pressure calculated.

Brief Description of the Drawings

Fig. 1 is a block diagram showing a main portion of an electronic blood pressure monitor.

Fig. 2 is a view for illustrating a principle of detection of blood pressure when the present electronic blood pressure monitor is used.

Fig. 3 is a flow chart representing a procedure of measurement using the electronic blood pressure monitor.